SB/EM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES	218109US2PCT
DESIGNATED/ELECTED OFFICE (DO/EO/US)	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
CONCERNING A FILING UNDER 35 U.S.C. 371	**10/030158**

INTERNATIONAL APPLICATION NO. PCT/FR00/02177	INTERNATIONAL FILING DATE 28 July 2000	PRIORITY DATE CLAIMED 30 July 1999

TITLE OF INVENTION
PROCESS FOR DATA TRANSMISSION USING REPETITIVE SETS OF SPREADING SEQUENCES, AND THE CORRESPONDING TRANSMITTER AND RECEIVER

APPLICANT(S) FOR DO/EO/US
DANIELE Norbert et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.

4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).

5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
    a. ☐ is attached hereto (required only if not communicated by the International Bureau).
    b. ☒ has been communicated by the International Bureau.
    c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
    a. ☒ is attached hereto.
    b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
    a. ☐ are attached hereto (required only if not communicated by the International Bureau).
    b. ☐ have been communicated by the International Bureau.
    c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
    d. ☒ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).

10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).

12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

15. ☐ A FIRST preliminary amendment.

16. ☐ A SECOND or SUBSEQUENT preliminary amendment.

17. ☐ A substitute specification.

18. ☐ A change of power of attorney and/or address letter.

19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.

20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).

21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).

22. ☐ Certificate of Mailing by Express Mail

23. ☒ Other items or information:
    Request for Consideration of Documents Cited in International Search Report
    PCT/IB/304/Drawings (3 sheets)/PCT/IB/308/Notice of Priority/Amended Sheet (Page 10)

PCTUS1/REV03

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24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

			CALCULATIONS	PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1040.00			
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00			
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00			
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00			
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00			

ENTER APPROPRIATE BASIC FEE AMOUNT =			$890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).			$0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	6 - 20 =	0	x $18.00	$0.00	
Independent claims	1 - 3 =	0	x $84.00	$0.00	
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00	

TOTAL OF ABOVE CALCULATIONS =		$890.00	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.		$0.00	

SUBTOTAL =		$890.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +		$0.00	

TOTAL NATIONAL FEE =		$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐		$0.00	

TOTAL FEES ENCLOSED =		$890.00	
		Amount to be: refunded	$
		charged	$

a. ☒   A check in the amount of   **$890.00**   to cover the above fees is enclosed.

b. ☐   Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒   The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. ____15-0030____   A duplicate copy of this sheet is enclosed.

d. ☐   Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Registration No. 34,423

|||||||||||| (barcode) 22850

Surinder Sachar (signature)

SIGNATURE

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REGISTRATION NUMBER

Jan 30 2002

DATE

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PROCESS FOR DATA TRANSMISSION USING REPETITIVE SETS OF SPREADING SEQUENCES, AND THE CORRESPONDING TRANSMITTER AND RECEIVER

DESCRIPTION

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Technical domain

The purpose of this invention is a process for transmission of data using repetitive sets of spreading
10   sequences, and a corresponding transmitter and receiver.

The invention is broadly applied for digital communications and more particularly for Wireless Local Area Networks (WLANs), Wireless subscriber Local Loops
15   (WLL), mobile telephony, intelligent building management systems and remote charging, communication for transport, cable television, multimedia service on cable networks, etc.

20   ### State of prior art

The invention relates to the spectrum spreading technique. It is known that this technique consists of modulating a digital symbol to be transmitted by a pseudo random sequence known to the user. Each
25   sequence is composed of N elements called "chips" that have a duration of one N^{th} of the duration of a symbol. The result is a signal for which the spectrum is spread over a range N times wider than the range of the original signal. On reception, demodulation consists
30   of correlating the received signal with the sequence used in sending to find the initial symbol.

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This technique has many advantages, but it cannot overcome a disadvantage related to an interference effect between symbols which originates as follows. In a radioelectric channel, the wave that propagates from the transmitter to the receiver may follow various paths such that several signals reach the receiver at different time, with different amplitudes and phases, for the same transmitted signal. Therefore the response of the channel to the transmitted signal is spread. Since the sent signal is usually short, it can be treated like a pulse and it is then referred to as a pulse response. In high throughput systems, these various replicas of the same signal can interfere with other signals.

Figure 1 illustrates this phenomenon. It shows the pulse response $h(t)$ of a channel as a function of time. On part A, it is assumed that a pulse was transmitted at a given time and that a first signal a_1 was received with a given delay τ_1, followed by a replica a_2 at time $\tau_1 + Tm$, where Tm is the time by which the second path lags behind the first. On part B, it is assumed that a second signal was sent after an interval Ts equal to the duration of a symbol and it is also assumed that this interval is equal to the delay Tm. It is also assumed that the properties of the channel are not modified within the interval Ts, in other words the delay τ_2 is equal to τ_1 and T_m remains constant. A signal b_1 is then received at time τ_2 followed by a replica b_2 at time $\tau_2 + T_m$.

Since it is assumed that Ts=Tm, it is obvious that the signals a_2 and b_1 will interfere and degrade

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reception. This source of degradation can be avoided by taking steps such that b_1 appears beyond a_2, in other words the duration Ts of the symbols is greater than the spreading Tm of the pulse response. In other words, the symbol flow rate must be less than 1/Tm. The constraint on the flow rate is greater when the pulse response is spread more.

The purpose of the invention is to overcome this disadvantage. By reducing the interference phenomenon between symbols, the invention enables higher flow rates in environments in which spreading of the pulse response of the channel is much greater than the duration of the symbol (up to 16 times in an example described later).

Document EP-A-0 693 834 describes a CDMA type mobile radiocommunication system in which the base station / mobile station link uses one or the other spreading sequence, the sequence being used in sending being identified such that the mobile station can unspread the received signal. The signal can be transmitted on three parallel channels using three different codes, to increase the information flow rate.

Description of the invention

The invention recommends that successive symbols should be processed with different pseudo random sequences in order to reduce the risks of interference between symbols, since this makes it possible to better discriminate received signals on reception. According to the invention, the number of different successive sequences is limited to a fixed number S. Beyond S

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sequences, the previously used sequences are reused. In other words, packets of S symbols can be processed by repetitive sets of S sequences. The result is that the time interval after which the same pseudo random sequence is repeated is no longer Ts, but becomes S times Ts. Therefore the constraint on the duration of the symbol is no longer Ts > Tm, but becomes STs > Tm. In terms of throughput, this means that for a given spreading, the authorized throughput is S times higher than in prior art. The upper limit is no longer 1/Tm, but becomes S/Tm.

This process that consists of processing packets of S symbols in repetitive sets of S pseudo random sequences can be further improved by processing several packets of S symbols in parallel, each with different sequence sets.

Therefore, more precisely, the purpose of the invention is a process for data transmission by spectrum spreading in which:

- in sending: symbols are built up from the data to be transmitted, and are modulated by spectrum spreading using pseudo-random sequences,

- on reception: the received signal is correlated with the pseudo-random sequences used in sending, the symbols sent are found and the data are restored,

this process being characterized in that:

a) in sending:

i) a set of S successive different pseudo-random sequences is built up, in which S is equal to at least 2,

ii) the symbols to be transmitted are grouped into successive packets each containing S symbols,

iii) the S successive symbols of a packet are modulated by the S successive pseudo-random sequences of the set of sequences,

iv) operation iii) is repeated for successive packets of S symbols, the pseudo-random sequences in the set thus being used repetitively,

b) on reception:

the received signal is correlated with each of the S pseudo-random sequences used in sending, the successive packets of symbols are restored and the corresponding data are restored.

The conversion made during transmission could be a summation.

In one particular embodiment, several packets of S symbols are processed in parallel.

Another purpose of the invention is a transmitter and a receiver for embodiment of this process.

Brief description of the drawings

- figure 1, already described, illustrates the interference phenomenon between symbols;
- figure 2 shows an embodiment of a transmitter according to the invention;
- figure 3 shows an embodiment of a receiver according to the invention.

Description of particular embodiments

Data to be transmitted are firstly organized into symbols using standard techniques. Each symbol may include one or several bits. The symbols are then organized in packets of S. If required, parallel processing can also be carried out, L packets of S symbols are used in parallel giving a total of M = LS symbols. The following symbols are organized in the same way to build up a new set of M symbols and so on.

Table I illustrates this series-parallel organization. Each box represents a symbol. The first set of symbols is denoted $S\frac{1}{ij}$ where i denotes the row in the table, in other words the rank of the packet (where i varies from 1 to L) and j is the column, in other words the rank in the packet (where j varies from 1 to S). In the second set, the LS symbols are denoted $S\frac{2}{ij}$ and so on.

j \ i	1	2		S	1	2		S	
1	$S\frac{1}{11}$	$S\frac{1}{12}$		$S\frac{1}{1S}$	$S\frac{2}{11}$	$S\frac{2}{12}$		$S\frac{2}{1S}$	$S\frac{3}{11}$
2	$S\frac{1}{21}$	$S\frac{1}{22}$		$S\frac{1}{2S}$	$S\frac{2}{21}$	$S\frac{2}{22}$		$S\frac{2}{LS}$	$S\frac{3}{21}$
			$S\frac{1}{ij}$				$S\frac{2}{ij}$		
L	$S\frac{1}{L1}$	$S\frac{1}{L2}$		$S\frac{1}{Ls}$	$S\frac{2}{L1}$	$S\frac{2}{L2}$		$S\frac{2}{LS}$	$S\frac{3}{L1}$

Table I

All these symbols are processed by spectrum spreading using LS different pseudo-random sequences, preferably orthogonal. These sequences are organized

as shown in table II. They are denoted C_{ij}, where i
varies from 1 to L and j varies from 1 to S.

i ＼ j	1	2		S
1	C_{11}	C_{12}		C_{1S}
2	C_{21}	C_{22}		C_{2S}
			C_{ij}	
L	C_{L1}	C_{L2}		C_{LS}

Table II

A symbol S_{ij} in table I is processed by the
corresponding pseudo-random sequence C_{ij} in table II.
When the M sequences have been used for a set of M
symbols, the same sequences are reused for the next set
of M symbols and so on. Therefore, the interval at
which sequences are reused is ST_S.
    Some numerical examples are given for explanatory
purposes to illustrate the advantages provided by the
invention; these examples are in no way restrictive.
It is assumed that work is done with a binary flow rate
of 2 Mbits/s in QPSK (Quaternary Phase Shift Keying)
modulation. Therefore the number of bits per symbol is
2. The duration Ts of a symbol is 1 µS. With a
process in accordance with the state of prior art, this
would mean that spreading of the channel Tm should be
limited to 1 µs. The invention uses L channels in
parallel (where L=M/S). Therefore the number of bits
transmitted in a symbol period Ts is equal to m = 2L.
Table III contains a few examples of maximum spreading
Tm_{max} that can be allowed for two values of M (8 and

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16), and 3 values of S (4, 8 and 16 respectively) for each.

	M=8	M=16
S=4	m=4 bits/symb Tm_{max}=8 µs	m=8 bits/symb Tm_{max}=16 µs
S=8	m=2 bits/symb Tm_{max}=8 µs	m=4 bits/symb Tm_{max}=16 µs
S=16		m=2 bits/symb Tm_{max}=16 µs

Table III

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    Figures 2 and 3 illustrate example embodiments of a transmitter and a receiver according to the invention. In figure 2, the transmitter comprises a general input 10 into which data $\underline{d}$ to be transmitted

10 are input, a circuit 20 transforming these data into symbols (it may be phase shift keying (PSK) modulator), a means 30 of forming packets each containing S symbols, namely P_i (i varying from 1 to L). In the variant illustrated, the transmitter comprises a

15 series-parallel converter 40 with L outputs 40_1, 40_2, ..., 40_i, ..., 40_L outputting L packets P_i, a table 50 of pseudo-random sequences C_{ij}, with L outputs 50_1, 50_2, ..., 50_j, ... , 50_L outputting L sets of sequences, a circuit 60 of spreading symbols S_{ij} with sequences C_{ij}, this

20 circuit having L outputs 60_1, 60_2, ..., 60_i, ..., 60_L outputting spread spectrum symbols, an adder 70 and finally transmission means symbolized by an antenna 80.

    The receiver shown in figure 3 comprises reception means symbolized by the antenna 100, a bank of M

matched filters 110_1, …, 110_M, each of these filters being matched to one of the pseudo-random sequences C_{ij} used in sending, a bank of M circuits 120_1, …, 120_M estimating the energy (or the amplitude) of signals output by the previous matched filters, a circuit 130 with M inputs 132_1, …, 132_M and L outputs 134_1, …, 134_L determining which of the M input channels contain maximum energy and outputting a selection signal on one or several of the L outputs, L circuits 140_1, …, 140_L with M inputs connected to the outputs of M matched filters and selecting one among M inputs as a function of the received selection signal, L demodulators 150_1, …, 150_L, for example of the PSK type, a circuit 160 putting L packets of symbols output by the demodulators into series, a circuit 170 restoring data $\underline{d}$ on a general output 180.

Processing in parallel is simply an option, the essential feature of the invention being that a set of different successive sequences is used.

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CLAIMS

1. Spectrum spreading data transmission process in which:

   - in sending: symbols are built up from the data to be transmitted, and are modulated by spectrum spreading using pseudo-random sequences,

   - on reception: the received signal is correlated with the pseudo-random sequences used in sending, the symbols sent are found and the data are restored,

this process being characterized in that:

   a) in sending:

   v)   a set of S successive different pseudo-random sequences is built up, in which S is equal to at least 2,

   vi)   the symbols to be transmitted are grouped into successive packets each containing S symbols,

   vii) the S successive symbols of a packet are modulated by the S successive pseudo-random sequences of the set of sequences,

   viii) operation   iii)   is   repeated   for successive packets of S symbols, the pseudo-random sequences in the set thus being used repetitively,

   b) on reception:

the received signal is correlated with each of the S pseudo-random sequences used in sending, the successive packets of symbols are restored and the corresponding

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data are restored.packets of symbols are restored and the corresponding data are restored.

2. Process according to claim 1, in which several packets of S symbols are processed in parallel.

3. Transmitter for embodiment of the process according to claim 1, comprising a general input (10), means (20) of receiving data to be transmitted and building up symbols, and means (60) of modulating these symbols by spectrum spreading using pseudo-random sequences, characterized in that it comprises:

- means (50) of building up a set of S successive different pseudo-random sequences,

- means (30, 40) of grouping symbols to be transmitted into successive packets each containing S symbols,

- means (60) of modulating the successive symbols of a packet by S successive pseudo-random sequences of the set of sequences, to reiterate this modulation for successive packets of symbols, the pseudo-random sequences of the set thus being used repetitively.

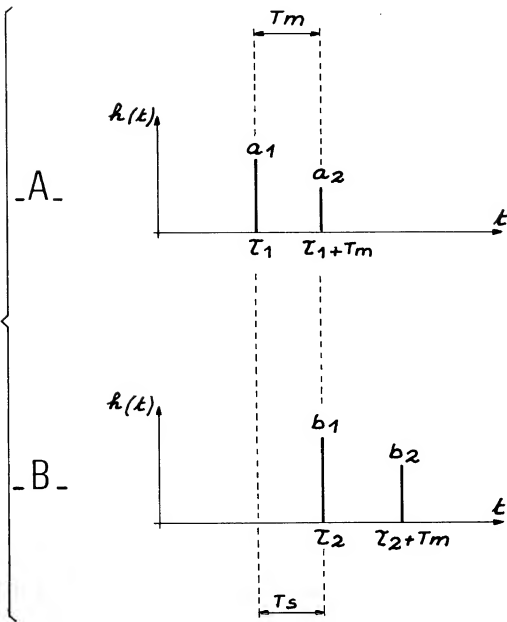4. Transmitter according to claim 3, in which the means process packets of successive symbols in series and in parallel.

5. Receiver for embodiment of the process according to claim 1, comprising means of correlating a reception signal with pseudo-random sequences and of outputting symbols, and means of restoring the data starting from these symbols, characterized in that it comprises:

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    - means (110_1, …, 110_M) of correlating the received
signal with S pseudo-random sequences,

    - means (120_1, …, 120_M) (130) (140_1, …, 140_L) (150_1,
…, 150_2) of restoring packets of S symbols,

5   - means (170) of restoring the corresponding data
on a general output (180).

    6. Receiver according to claim 5, in which the
means process packets of successive symbols in series
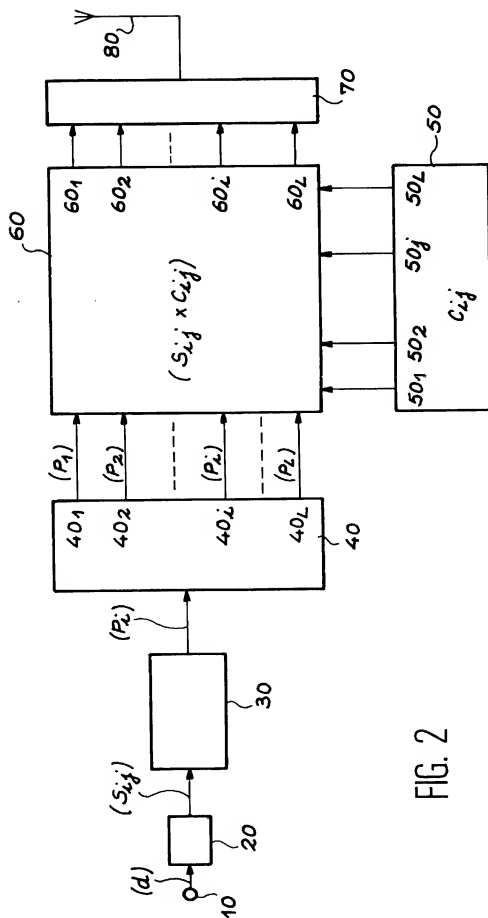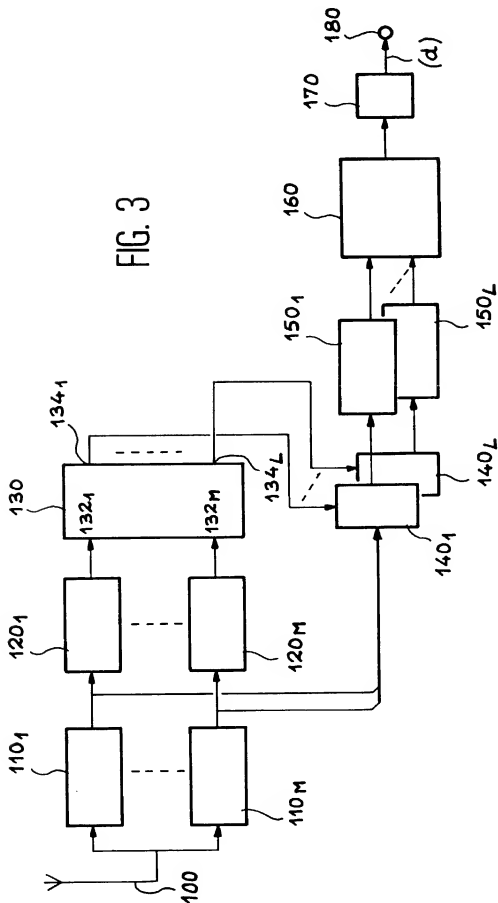and in parallel.

FIG. 1 {

_A_

_B_

FIG. 2

FIG. 3

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Declaration, Power Of Attorney and Petition

WE (I) the undersigned inventor(s), hereby declare(s) that :

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled
PROCESS FOR DATA TRANSMISSION USING REPETITIVE SETS OF SPREADING SEQUENCES, AND THE CORRESPONDING TRANSMITTER AND RECEIVER

the specification of which

      ☐ is attached hereto.

      ☐ was filed on

           as Application Serial No.

           and amended on

      ☒ was filed as PCT international application

           Number PCT/FR00/02177

           on July 28, 2000

           and was amended under PCT Article 19

           on June 07, 2001

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application (s)

Application No.	Country	Day/month/Year	Priority Claimed	
99 09947	FRANCE	30 July 1999	☒ YES	☐ NO
_____	_____	_____	☐ YES	☐ NO
_____	_____	_____	☐ YES	☐ NO
_____	_____	_____	☐ YES	☐ NO

We (I) hereby claim the benefit under Title 35, United States Code, § 119 (e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)

(Application Number)	(Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of prior application and the national or PCT International filing date of this application.

Application Serial No.	Filing Date	Status (pending, patented, abandoned)

And we (I) hereby appoint : Norman F. Oblon, Registration Number 24,618; Marvin J. Spivak, Registration Number 24,913; C, Irvin McClelland, Registration Number 21,214; Gregory J. Maier, Registration Number 25,599; Arthur I. Neustadt, Registration Number 24,854; Richard D. Kelly, Registration Number 27,757; James D. Hamilton, Registration Number 28,421; Eckhard H. Kuesters, Registration Number 28,870; Robert T. Pous, Registration Number 29,099; Charles L. Gholz, Registration Number 26,395; Vincent J. Sunderdick, Registration Number 29,004; William E. Beaumont, Registration Number 30,996; Steven B. Kelber, Registration Number 30,073; Robert F. Gnuse, Registration Number 27,295; Jean-Paul Lavalleye, Registration Number 31,451; William B. Walker, Registration Number 22,498; Timothy R. Schwartz, Registration Number 32,171; Stephen G. Baxter, Registration Number 32,884; Martin M.,. Zoltick, Registration Number 35,745; Robert W. Hahl, Registration Number 33,893; and Richard L. Treanor, Registration Number 36,379; our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to the firm of OBLON, SPIVAK, McCLELLAND, MAIER & NEUSTADT, P.C., whose post Office Address is : Fourth Floor, 1755 Jefferson Davis Highway, Arlington, Virginia 22202.

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true ; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardise the validity of the application or any patent issuing thereon.

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Signature of Inventor

January 04, 2002

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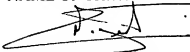
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NAME OF FIFTH INVENTOR

Signature of Inventor

Date

Residence : _____

Citizen of : _____

Post Office Address : The same as residence